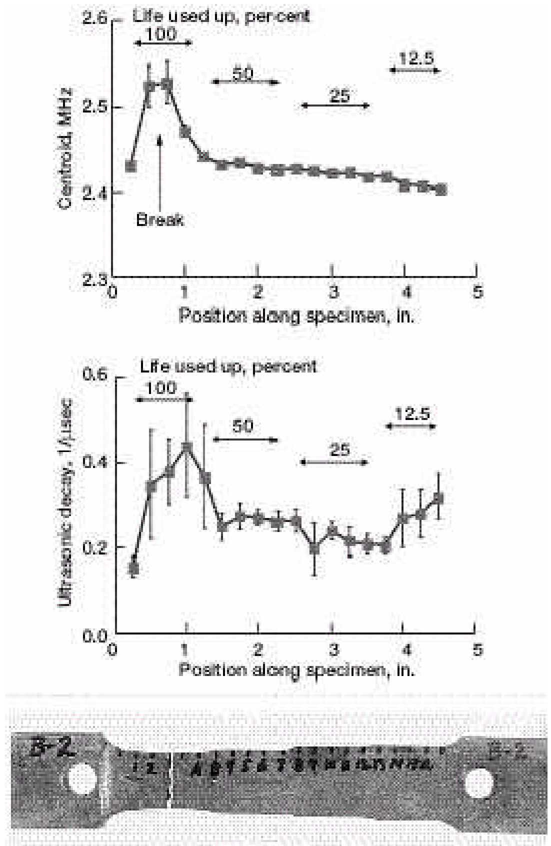
# Damage Assessment of Creep Tested and Thermally Aged Metallic Alloys Using Acousto-Ultrasonics

In recent years emphasis has been placed on the early detection of material changes experienced in turbine powerplant components. During the scheduled overhaul of a turbine, the current techniques of examination of various hot section components aim to find flaws such as cracks, wear, and erosion, as well as excessive deformations. Thus far, these localized damage modes have been detected with satisfactory results. However, the techniques used to find these flaws provide no information on life until the flaws are actually detected. Major improvements in damage assessment, safety, as well as more accurate life prediction could be achieved if nondestructive evaluation (NDE) techniques could be utilized to sense material changes that occur prior to the localized defects mentioned.

Because of elevated temperatures and excessive stresses, turbine components may experience creep behavior. As a result, it is desirable to monitor and access the current condition of such components. Research at the NASA Glenn Research Center involves developing and utilizing an NDE technique that discloses distributed material changes that occur prior to the localized damage detected by the current methods of inspection. In a recent study, creep processes in a nickel-base alloy were the life-limiting condition of interest, and the NDE technique was acousto-ultrasonics (AU). AU is an NDE technique that utilizes two ultrasonic transducers to interrogate the condition of a test specimen. The sending transducer introduces an ultrasonic pulse at a point on the surface of the specimen while a receiving transducer detects the signal after it has passed through the material. The goal of the method is to correlate certain parameters of the detected waveform to characteristics of the material between the two transducers. Here, the waveform parameter of interest is the attenuation due to internal damping for which information is being garnered from the frequency domain. The parameters utilized to indirectly quantify the attenuation are the ultrasonic decay rate as well as various moments of the frequency power spectrum. A new, user-friendly, graphical interface AU system was developed at NASA Glenn. This system is an all-inclusive, multifunction system that controls the sending and receiving ultrasonic transducers as well as all posttest signal analysis. The system's postprocessing software calculates the multiple parameters used to study the material of interest.




*Plots of the centroid of the power spectrum and ultrasonic decay rate as functions of position on a multistep specimen. The levels of used-up creep life are 100, 50, 25, and 12.5 percent for each of the four gauge widths, respectively. The specimen was creep tested at 1350 °F for 1395 hr.*

The newly developed AU system was employed to monitor the state of damage due to creep testing in the nickel-base alloy, Udimet 520. A stepped specimen (i.e., varying cross-sectional area) was employed, which allowed for a post mortem NDE analysis of the various levels of used-up creep life. The AU method was able to detect material changes (i.e., distributed damage prior to the formation of localized cracks) as a function of used-up creep life. The AU parameters that displayed a functional dependence on used-up creep life were the centroid of the power spectrum and the ultrasonic decay rate (see the figure). With further research, confidence can be achieved and a protocol developed for utilizing AU as an early damage detection tool for turbine components that are exposed to various stress and temperature environments.

# References

1. Gyekenyesi, A.L., et al.: Damage Assessment of Creep Tested and Thermally Aged Udimet 520 Using Acousto-Ultrasonics. Submitted to ASME Turbo Expo 2001, New Orleans, Louisiana, June, 2001.

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